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Chapter 2 Solving Linear Inequalities

Dear Family,

There are many different types of museums; art and science museums, museums that tell the history of music, sports, etc. A town museum may shed some light on how the town received its name and other important information about the town.

Most museums charge a fee to walk through their exhibits. How old you are often affects how much you and your family will need to pay to experience the museum. Many of the admission prices are given as some form of linear inequality. For example, a local art museum may allow children under the age of 2 to enter without charge. Or, you may receive a discounted rate if you are age 65 or older. So, you can say "age < 2" is free and "age ≥ 65" receives a discount.

Have your student research museums in your area. Have them gather the admission fees from the different museums and represent the results using mathematical inequalities.

- What types of museums do you have locally?
- Is there a difference between the inequalities "children age 2 and under are free" and "children under the age of 2 are free?"
- Are any of your local museums free, but take donations? How could you write an inequality for donations?
- Are there limits for the time of day or time of year when you can visit the museums in your area?

Some limits are open-ended—stating only a minimum age for entrance into the museum. For example, the 65 and older rule stated above is open-ended. On the other hand, some limits are bounded—they have a minimum and a maximum. Have your student write a short summary using his or her inequalities.

As a family, visit some of your local museums. As you walk around, see if you notice any other inequalities.

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Nombre _____ Fecha_____

Capitulo 2

Resolver desigualdades lineales

Estimada familia:

Hay muchas clases diferentes de museos; museos de artes y ciencias, museos que cuentan la historia de la música, los deportes, etc. Un museo sobre una ciudad puede aclarar por qué la ciudad se llama así y dar más información importante sobre la ciudad.

No es gratis recorrer las exhibiciones de la mayoría de los museos. En general, la edad influye en la cantidad que usted y su familia deberán pagar para conocer el museo. Muchos precios de los boletos se dan en forma de una desigualdad lineal. Por ejemplo, un museo de arte local puede permitir que los niños menores a 2 años ingresen sin cargo. O tal vez reciban una tarifa con descuento si tienen 65 años o más. Entonces, pueden decir "edad < 2" es gratis y "edad ≥ 65" recibe un descuento.

Pida a su hijo que investigue sobre museos en su área. Pídale que reúna las tarifas de ingreso de diferentes museos y representen los resultados usando desigualdades matemáticas.

- ¿Qué clases de museos hay en su área?
- ¿Hay alguna diferencia entre las desigualdades "niños de 2 años o menos entran gratis" y "niños menores a 2 años entran gratis"?
- ¿Alguno de los museos locales son gratis, pero aceptan donaciones? ¿Cómo podrían escribir una desigualdad para las donaciones?
- ¿Hay límites de horario según el día o la época del año cuando pueden visitar los museos de su área?

Algunos límites son abiertos; enuncian solo la edad mínima para entrar al museo. Por ejemplo, la regla de 65 años o más que se menciona es abierta. Por otra parte, algunos límites son definidos; tiene un mínimo y un máximo. Pida a su hijo que escriba un resumen corto usando sus desigualdades.

En familia, visiten algunos de los museos locales. Mientras los recorren, fíjense si observan otras desigualdades.

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2.1 Start Thinking

When constructing an equation to solve a real-life problem, it is important to remember that equations are solved for one particular solution.

However, some situations require the possibility of more than one solution. Describe a real-life situation where more than one solution makes sense.

2.1 Warm Up

Use <, >, or = to compare.

1. $4 __?__ 4$ **2.** $7 __?__ -2$ **3.** $-5 __?__ 4$

4. $4 __?__ -3$ **5.** $3 __?__ -6$ **6.** $4 __?__ -1$

2.1 Cumulative Review Warm Up

Solve the equation. Check your solution.

1. $16 + x = 5x$ **2.** $4p + 10 = p - 14$

3. $4t - 17 = 5 + 6t$ **4.** $-4r - 11 = 14r + 9$

5. $8 - 2x + 13x = x - 2$ **6.** $-w + 3 - w = 7 - 4w$

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Name _____ Date _____

2.1 Practice A

In Exercises 1–6, write the sentence as an inequality.

1. A number x is less than 2.
2. A number m plus 4 is greater than or equal to 7.
3. Ten is no less than a number q multiplied by 6.
4. Four times a number p is more than 22.
5. One-third of a number t is less than or equal to 5.
6. Six is more than the difference of a number d and 1.
7. There are 65 people in a restaurant. The restaurant has a maximum capacity of 84 people. Write an inequality that represents the number x of additional people who can enter the restaurant.

In Exercises 8–13, tell whether the value is a solution of the inequality.

8. $u + 7 < 4$; $u = 2$
9. $8 - x \geq 3$; $x = 2$
10. $5p \geq 24$; $p = 6$
11. $15 \leq 4w$; $w = 3$
12. $-3 > -\frac{x}{5}$; $x = 10$
13. $\frac{8}{y} \leq 6$; $y = 2$
14. The largest alligator ever caught in Mississippi weighed 727 pounds.
    a. Write an inequality that represents the weights of every other alligator that has ever been caught in Mississippi.
    b. Is 750 pounds a solution to your inequality? Explain.

In Exercises 15–20, graph the inequality.

15. $x \geq 4$
16. $j < 3$
17. $m \leq -1$
18. $-3 < t$
19. $-5 \geq q$
20. $w < -4$

In Exercises 21–23, write and graph an inequality for the given solution set.

21. $\{x \mid x > 3\}$
22. $\{p \mid p \leq 0\}$
23. $\{w \mid w \geq -6\}$
24. To qualify for an award, a student volunteers no less than 5 hours each week at the local hospital. Write an inequality that represents how many hours the student volunteers each week.

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2.1 Practice B

In Exercises 1–4, write the sentence as an inequality.

1. A number x plus 10 is more than 2.
2. Twelve is no less than the sum of a number n and 3.
3. One-half of a number p is at least 100.
4. Six is greater than or equal to the quotient of a number y and 2.5.

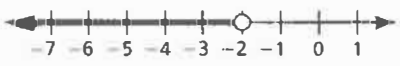
In Exercises 5–10, tell whether the value is a solution of the inequality.

5. $-5 \leq -\frac{z}{3}$; $z = 2$
6. $\frac{10}{r} \geq 1$; $r = 5$
7. $21 \geq -4t + 3$; $t = -6$
8. $-9 \div (3a) > -2$; $a = 3$
9. $12 < \frac{18}{3g} + 12$; $g = -2$
10. $\frac{4n}{8} + 3 \leq 2$; $n = 4$
11. The winning swim team earned 245 points. The other teams earned at least 72 points less.
    a. Write an inequality that represents the points that the other teams earned.
    b. Was one of the teams able to earn 180 points? Explain.

In Exercises 12–17, graph the inequality.

12. $-2 \geq k$
13. $-4 < f$
14. $m \leq -3$
15. $-y < 3$
16. $\frac{1}{3} \geq j$
17. $n < -|-4|$

In Exercises 18 and 19, write an inequality that represents the graph.

18. 

19.

20. An upcoming marathon's qualifying time for males age 18–34 is 3 hours.
    a. Write an inequality that represents how many hours a male runner could take to run a marathon in order to qualify.
    b. Will a runner with a fastest marathon time of 3 hours 9 minutes qualify for the upcoming marathon? Explain.

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2.1 Enrichment and Extension

Sets of Numbers

In Exercises 1–4, evaluate the expression when (a) $x = -1$, (b) $x = 0$, and (c) $x = 1$. Then determine whether the result is a whole number, an integer, or a rational number.

1. $\frac{x^2 + 1}{x - 2}$

2. $\frac{-2x}{x^2 + 1}$

3. $\frac{1 - x}{x^2 + 2}$

4. $\frac{x^2 + 1}{x^2 + 1}$

5. Order the value of the expressions x, $x + 2$, and $x - 1$ from least to greatest. Does the order change depending on whether x is positive or negative? Explain.

Tell whether the statement is *true* or *false*. If false, give a counterexample.

6. The division of two whole numbers is always a non-integer rational number.

7. The sum of two positive integers is always a whole number.

8. The sum of two non-integer rational numbers is always a non-integer rational number.

9. The product of two non-integer rational numbers is always a non-integer rational number.

10. The quotient of two integers is always a non-integer rational number.

11. The square of a non-integer rational number is always a non-integer rational number.

12. The sum of two whole numbers is always a whole number.

13. The difference of two whole numbers is always a whole number.

14. The opposite number of an integer is always negative.

15. The opposite of a whole number is always negative.

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2.1 Puzzle Time

What Does A Cricket Like To Do At Recess?

Write the letter of each answer in the box containing the exercise number.

Write the sentence as an inequality.

1. A number x is less than or equal to 4.

D. $x < 4$ **E.** $x \leq 4$ **F.** $x \geq 4$

2. A number k decreased by 11 is greater than 3.

M. $11 - k > 3$ **N.** $k - 11 < 3$ **O.** $k - 11 > 3$

3. Sixteen is less than a number r divided by 8.

L. $16 > \frac{r}{8}$ **M.** $16 < \frac{r}{8}$ **N.** $16 < 8r$

4. Twelve is no more than the difference of a number t and 5.

J. $12 \leq t - 5$ **K.** $12 \geq t - 5$ **L.** $12 \leq 5 - t$

5. Seven times the sum of a number d and 11 is less than 22.

P. $7d + 11 < 22$ **Q.** $7(d + 11) \leq 22$ **R.** $7(d + 11) < 22$

Tell whether the value is a solution of the inequality.

6. $a + 6 < -2; a = -8$

O. yes **P.** no

7. $32 \leq -4n - 15; n = 14$

T. yes **U.** no

8. $\frac{4m}{5} - 2 > 3; m = 10$

P. yes **Q.** no

4	7	3	6		5	2	8	1

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2.2 Start Thinking

When making a purchase, it is important to have more money than the cost of the merchandise. Suppose you have a $20 bill and have already placed bread, eggs, and cereal into your cart. How could you represent the amount of money you have left to spend on milk with an inequality?

2.2 Warm Up

Solve the equation.

1. $x + 1 = 0$ **2.** $y - 3 = 0$ **3.** $x - 3 = 3$

4. $x + 1 = -1$ **5.** $a + 5 = -15$ **6.** $x - 5 = 2$

2.2 Cumulative Review Warm Up

Solve the equation.

1. $|x - 7| = 6$ **2.** $|3 - x| = 7$

3. $|4x + 1| = 2$ **4.** $|4x + 3| = 5$

5. $|m - 4| = 6$ **6.** $|q + 9| = 13$

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2.2 Practice A

In Exercises 1–3, tell which number you would add to or subtract from each side of the inequality to solve it.

1. $h + 3 < 8$ **2.** $p - 5 \geq 2$ **3.** $-3 > n - 1$

In Exercises 4–12, solve the inequality. Graph the solution.

4. $t - 3 > -2$ **5.** $4 < p - 2$ **6.** $2 \geq h - 5$

7. $v - 5 > -9$ **8.** $p + 3 \leq 4$ **9.** $-7 < 7 + t$

10. $6 + k > 5$ **11.** $12 \leq r + 5$ **12.** $w - (-4) < 8$

In Exercises 13–16, write the sentence as an inequality. Then solve the inequality.

13. A number minus 2 is greater than -10.

14. A number plus 7 is at most 4.

15. The difference of a number and 6 is less than 1.

16. Eight is greater than or equal to the sum of a number and 3.

17. You and your friend are planning to walk across an old bridge. The bridge can hold at most 1000 pounds. The total weight of the people currently on the bridge is 675 pounds. You weigh 156 pounds.

a. Write and solve an inequality that represents how much your friend can weigh within the limits of the bridge.

b. Your friend weighs 182 pounds. Can you and your friend both walk on the bridge? Explain.

18. The school baseball record for no-hitter innings is 112 in a season. This year's team currently has 87 no-hitter innings. What are the possible numbers of additional no-hitter innings the team can achieve to match or break the school record in a season?

19. Which of the following inequalities are equivalent to the inequality $5 < -y + b$, where b is a constant? Select all that apply. Justify your answer.

a. $5 + y + b < 0$ **b.** $y < b - 5$

c. $b - 5 > y$ **d.** $b - 5 < y$

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2.2 Practice B

In Exercises 1–9, solve the inequality. Graph the solution.

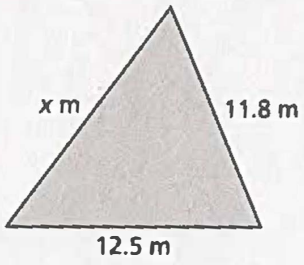
1. $w + 6 \leq 2$
2. $m - 3 > -6$
3. $4 < 4 + s$
4. $7 \leq x + 15$
5. $p - (-3) > 10$
6. $q + 6 - 5 > 4$
7. $3 - 11 + t > -2$
8. $4 \leq 6a - 4a - 2$
9. $22 + (-9c) + 10c < 5 + 1$

In Exercises 10–13, write the sentence as an inequality. Then solve the inequality.

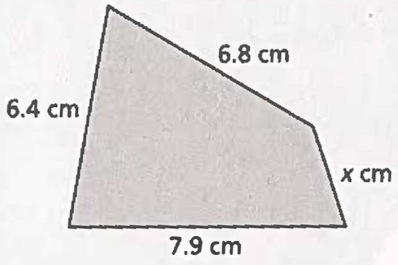
10. A number plus 10 is less than 34.
11. A number minus 8 is at least 14.
12. The sum of a number and 7 is less than 15.
13. Nine is less than or equal to the difference of a number and 1.
14. You order a new pair of running shoes from a website that offers free shipping on orders of \$75 or more. Your shoes cost \$69.95.
    a. Write and solve an inequality that represents how much more you must spend to get free shipping.
    b. The cost of shipping your shoes is \$7.79. Would you purchase another item in order to get free shipping? Explain.

In Exercises 15 and 16, write and solve an inequality to find the possible values of *x*.

15. Perimeter < 37.8 meters



16. Perimeter ≤ 24.1 centimeters



17. Write and solve an inequality that represents the numbers that are *not* solutions of each inequality.
    a. $x - 7 \leq -10$
    b. $x + 3 > 2.5$

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2.2 Enrichment and Extension

Explore Positive and Negative Variables

In Exercises 1–4, simplify the expression. Justify your answer with the Properties of Addition and Multiplication.

1. $-x + 6 + x - a + a$

2. $1 + (1 - p) + p - 1$

3. $-a - b - c + a + b + c$

4. $4 - b + 2 - (3 - b)$

5. Simplify the expression $-x - y - z - 1 + 1 + z + y + x$ assuming all variables are positive integers.

6. In Exercise 5, assume all variables are negative. Will this change the answer? Explain.

7. In Exercise 5, assume the variables are both positive and negative integers. Will this change the answer? Explain.

8. Is it possible to write an expression that would be simplified differently if the variables are either positive or negative?

9. Is a^2 always equivalent to $-a^2$? Why, or why not? Give an example.

10. Is a^2 always equivalent to $(-a)^2$? Why, or why not? Give an example.

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2.2 Puzzle Time

Where Did The Granite Go On Saturday Night?

Write the letter of each answer in the box containing the exercise number.

Solve the inequality.

1. $x + 12 < -4$
2. $-3 \geq x - 11$
3. $x - 6 < -7$
4. $2 \geq x - 1$
5. $x + 9 < 10$
6. $12 + x > 8$
7. $x - (-14) \geq 30$
8. $x - 22 + 16 < -3$
9. $5 > x - (-5)$
10. $7 - 26 + x \geq -11$
11. $36 \leq 6x - 5x - 16$

Write the sentence as an inequality. Then solve the inequality.

12. A number x plus 24 is greater than 23.
13. A number x minus 5 is at least -4.
14. The sum of a number x and 19 is less than or equal to 35.
15. The monthly minutes on your cell phone can add up to no more than 700 minutes. You have used 648 minutes. Write and solve an inequality that represents how many more minutes that you can use during the rest of the month.
16. The side lengths of a triangle are 11.3 centimeters, 14.7 centimeters, and x centimeters. The perimeter of the triangle is less than 44 centimeters. Write and solve an inequality to find the possible values of x.

Answers

T. $x \geq 16$
L. $x < 0$
T. $x < 3$
Y. $x > -4$
H. $x \geq 8$
O. $x \leq 3$
A. $x \leq 8$
L. $x < 1$
A. $x < -16$
E. $x < -1$
T. $x \geq 52$
L. $x + 24 > 23; x > -1$
C. $x + 648 \leq 700; x \leq 52$
S. $x - 5 \geq -4; x \geq 1$
R. $x + 11.3 + 14.7 < 44; x < 18$
B. $x + 19 \leq 35; x \leq 16$

11	4		7	10	3		15	16	6	13	8	1	9		14	2	5	12

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2.3 Start Thinking

Choose any two numbers and compare them with an inequality symbol ($<$ or $>$). Multiply each number by -1. Is the new inequality still true? Continue this exercise by dividing the original inequality by -1. Is this new inequality still true? Choose another negative number to multiply and divide by, using your original inequality again.

Write a hypothesis to explain what you must do to the inequality symbol when you multiply or divide by a negative number.

2.3 Warm Up

Solve the equation.

1. $6g = 18$

2. $p \div 6 = 2$

3. $-7r = 63$

4. $\frac{x}{7} = 9$

5. $-56 = 8s$

6. $5q = 50$

2.3 Cumulative Review Warm Up

Simplify the expression.

1. $|-8|$

2. $|13| + |-13|$

3. $|-6 \div (-6)|$

4. $\left|\frac{26}{-2}\right|$

5. $|14|$

6. $2 - |2|$

7. $|-7.7 \div 11|$

8. $-\left|\frac{-10}{5}\right|$

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2.3 Practice A

In Exercises 1–6, solve the inequality. Graph the solution.

1. $3x \leq 9$
2. $2m < -6$
3. $-18 < 6t$
4. $40 \leq 8p$
5. $\frac{b}{3} \geq -1$
6. $\frac{x}{3} \leq 8.7$

In Exercises 7–12, solve the inequality. Graph the solution.

7. $-5j \leq 10$
8. $-4t \geq 4$
9. $-14 > -7y$
10. $-24 < -6a$
11. $\frac{k}{-2} > 2$
12. $\frac{h}{-1} < 7$

13. You have \$25 to buy 6 fishing lures. Write and solve an inequality that represents the prices you can pay per fishing lure.

In Exercises 14–16, solve the inequality. Use a graphing calculator to verify your answer.

14. $54 \leq 9g$
15. $13m > 65$
16. $3 < -\frac{3}{7}d$

17. Describe and correct the error in solving the inequality.

✗
$$5 < \frac{w}{-3}$$
$$-3 \bullet (5) > -3 \bullet \left(\frac{w}{-3}\right)$$
$$-15 > w$$
The solution is $w > -15$.

18. You bike for 2 hours at a speed no faster than 17.6 miles per hour.

    a. Write and solve an inequality that represents the possible numbers of miles you bike.

    b. The bike portion of an Ironman competition is 112 miles. Your friend says that if you continue to bike at this pace, you will be able to complete the bike portion of the Ironman in less than 6.5 hours. Is your friend correct? Explain.

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2.3 Practice B

In Exercises 1–6, solve the inequality. Graph the solution.

1. $56 \leq 8b$
2. $-14 < 7t$
3. $\frac{x}{2} \leq 1.7$
4. $\frac{p}{2} \geq -3$
5. $15 > \frac{2}{3}w$
6. $-22 \leq \frac{11}{2}h$

In Exercises 7–12, solve the inequality. Graph the solution.

7. $-21 < -7a$
8. $-18 > -6u$
9. $\frac{n}{-2} < 3$
10. $\frac{w}{-3} > 3$
11. $-7 \leq -\frac{1}{3}c$
12. $-15 > -\frac{3}{5}a$

13. You are taking tickets at a concert. You have determined that you are taking 16 tickets each minute. Write and solve an inequality to determine how many minutes it will take for you to take at least 136 tickets.

In Exercises 14–16, solve the inequality. Use a graphing calculator to verify your answer.

14. $3 < \frac{t}{-3}$
15. $3g \leq \frac{2}{5}$
16. $1.2v > 7.2$

17. You have \$850 to buy new carpet for the game room. The dimensions of the game room are 20 feet by 12 feet. Write and solve an inequality that represents the costs per square foot that you can pay for the new carpet. Specify the units of measure in each step.

18. You run for 3 hours at a speed no faster than 8.2 miles per hour.

    a. Write and solve an inequality that represents the possible numbers of miles you run.

    b. A marathon is approximately 26.2 miles. Your friend says that if you continue to run at this speed, you will not be able to complete a marathon in less than 4 hours. Is your friend correct? Explain.

19. The base of a triangle with a height of 7 units is represented by the formula $b = \frac{2}{7}A$. The base of the triangle is less than 10 units. Write and solve an inequality that represents the possible area A of the triangle.

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2.3 Enrichment and Extension

Explore Absolute Value

In Exercises 1–5, simplify the expression if $a = 2$, $b = -1$, and $c = 3$.

1. $\left|\frac{|a-5|+|bc|}{-2}\right|$
2. $|a|b-c|-ac|$
3. $|-a-b-c|-|a+b+c|$
4. $|a-b+2| \bullet b-(3-|b|)$
5. $b\left|\frac{c|-ab|}{ac-bc}\right|$

In Exercises 6–13, determine if the statement is *always true*, *sometimes true*, or *never true*. If sometimes true, find the values of x and y that make the statement true and the values of x and y that make the statement false. Explain your reasoning.

6. $|x|+|y|-(x+y)=0$
7. $|x|+|y| \leq |x+y|$
8. $|x|^{|y|} = x^y$
9. $|x|-|y| = |x-y|$
10. $|x^y| = |x|^{|y|}$
11. $|x|+|y| \geq |x+y|$
12. $|xy| = xy$
13. $x^2+|x||y|+y^2 = (x+y)^2$

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2.3 Puzzle Time

Did You Hear About The Two Punsters Who Told A Lot Of Jokes About Cats?

A	B	C	D	E	F
G	H	I	J	K	L
M	N				

Complete each exercise. Find the answer in the answer column. Write the word under the answer in the box containing the exercise letter.

$x \leq -25$ PLAY	$x \geq -48$ ANY
$x < -8$ KITTEN	$x \leq 21$ TREATS
$x \geq 11$ SAID	$x \geq 48$ EITHER
$x \leq 4$ THAT	$x < -48$ NOT
$x > -13$ YARN	$x \geq -12$ MORE
$x > 3$ WE'RE	$x < -\frac{2}{7}$ ABOUT
$x < -\frac{7}{2}$ THEY	$x < 3$ WE
$x \leq 5$ WON'T	$x \geq -84$ TWO
$x > -8$ TELL	$x > 12$ AND

Solve the inequality.

A. $3x < 9$

B. $-25 \leq -5x$

C. $\frac{x}{4} > -2$

D. $36 \geq -\frac{3}{4}x$

E. $-14 \leq \frac{7}{6}x$

F. $-10x > 35$

G. $-88 \geq -8x$

H. $\frac{x}{2} < -6$

I. $-27 > -9x$

J. $\frac{5}{8}x < -30$

K. $-2x > 16$

L. $\frac{x}{2} < -\frac{1}{7}$

M. You have saved some money to purchase five different songs to download to your portable music device. Solve an inequality that represents the prices you can pay for each song if you have saved no more than $20.

N. You are able to type 24 words in one minute. Solve an inequality that represents the number of minutes that you will need to type an essay that consists of at least 1152 words.

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2.4 Start Thinking

Business A buys an item at a price of \$175 for 50 units. The business pays a shipping company \$0.49 per item to transport the items to its store. The retail price is \$4.99 per each unit.

If Business A needs to make at least a \$1500 profit to meet its goal, how could you set up an inequality to represent this situation?

2.4 Warm Up

Solve the equation.

1. $13v - 9v - 15 = 77$
2. $8c + 7 + 3c = -15$
3. $3(z - 6) = 30$
4. $8 - 4(2m - 2) = 24$
5. $-3(7g + 2) = 36$
6. $-5h - 3(10 + h) = -6$

2.4 Cumulative Review Warm Up

Solve the literal equation for *y*.

1. $2y + 2x = 14$
2. $y + 19x = -27$
3. $10x + y = 47$
4. $3x + 6 = 6 - 5y$
5. $1 - \frac{2}{5}y = 4x - 3$
6. $2y = 3x - 9x$

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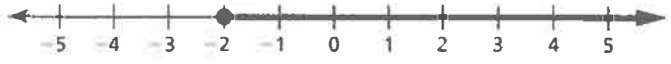
2.4 Practice A

In Exercises 1–3, match the inequality with its graph.

1. $6y - 5 \geq 7$ **2.** $3m + 5 \leq 8$ **3.** $-4x + 3 \leq 11$

A.

B.



C.

In Exercises 4–9, solve the inequality. Graph the solution.

4. $3x - 4 < 2$ **5.** $4t + 11 \geq 7$ **6.** $-6 \geq 9 - 5y$

7. $5 < -2t - 3$ **8.** $\frac{k}{3} + 6 < 7$ **9.** $2 + \frac{p}{2} \geq 7$

In Exercises 10–17, solve the inequality.

10. $5 - 4n < 8 - 5n$ **11.** $5k - 7 \geq 5k + 8$

12. $-3n - 4 > 4n + 10$ **13.** $7 + 9y < 19 - 3y$

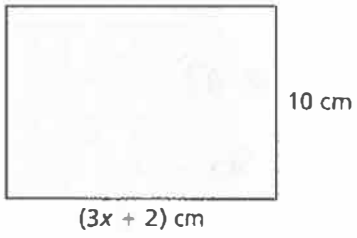
14. $9w - 4w + 6 \geq 1 + 5w$ **15.** $4k - 6 < 3k + k - 1$

16. $8(x - 3) > 4(2x - 6)$ **17.** $9(p + 2) \leq 3(3p - 5)$

18. The area of the rectangle shown is at most 140 square centimeters.

a. Write and solve an inequality to find the possible values of x.

b. Based on the answer in part (a), is it possible for the rectangle to have a length of 15 centimeters? Explain.



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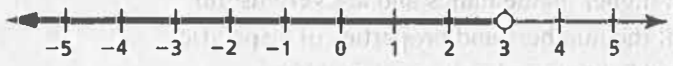
2.4 Practice B

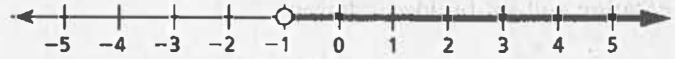
In Exercises 1–3, match the inequality with its graph.

1. $5(4 - y) < 25$ **2.** $-9k + 5 > 14$ **3.** $2(x - 7) < -8$

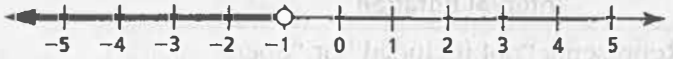
A.



B.



C.



In Exercises 4–9, solve the inequality. Graph the solution.

4. $6 < -5t - 4$ **5.** $\frac{m}{4} + 2 < 3$ **6.** $5 + \frac{k}{-2} \geq 2$

7. $\frac{d}{-6} + 7 < 11$ **8.** $4 < -2(y + 3)$ **9.** $24 \geq 6(w - 2)$

In Exercises 10–15, solve the inequality.

10. $-5n - 4 > 7n + 20$ **11.** $4k - 6 < 3k + k - 1$

12. $10h - 3h + 6 \geq 11 + 7h$ **13.** $6(t - 1) \leq 2(3t - 5)$

14. $12(x - 2) > 3(4x - 8)$ **15.** $6\left(\frac{1}{3}d + 4\right) > 2(d + 12)$

16. You must maintain a minimum balance of $50 in your checking account. You currently have a balance of $280.

a. Write and solve an inequality that represents how many $20 bills you can withdraw from the account without going below the minimum balance.

b. Your bank charges an ATM fee of $2.50, which is charged each time you withdraw $20. Write and solve an inequality that represents how many $20 bills you can withdraw from the account without going below the minimum balance in this situation.

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2.4 Enrichment and Extension

Methods of Describing Sets

Set-builder notation and *interval notation* are both mathematical shorthands that describe a set of numbers. They are frequently used in higher mathematics and are very useful. Set-builder notation is a quick way to state all the numbers and properties of a specific set, while interval notation is a representation of an interval as a set of numbers.

Example: Write the inequalities in interval notation and set-builder notation: $x < 0$ or $3 \leq x < 7$.

Set-builder notation	Interval notation
$\mathbb{R}$ stands for all real numbers. $\mathbb{Z}$ stands for integers. $\in$ stands for "is an element of." $\mid$ stands for "such that."	(Represents "not included" or "open." [Represents "included" or "closed." ∞ Is always expressed as "not included." $\cup$ Stand for "union" which replaces the word "or."
$x < 0$ or $3 \leq x < 7$ is written as $\{x \in \mathbb{R} \mid x < 0, 3 \leq x < 7\}$.	$x < 0$ or $3 \leq x < 7$ is written as $(-\infty, 0) \cup [3, 7)$.

Express the inequality or inequalities in both set-builder notation and interval notation. Then, if not graphed, graph each on a number line.

1. $-3 < x \leq 4$

2. $y \leq 1$ *or* $y > 13$

3. $x \leq -2$

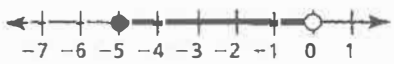
4. $p > 5$

5. $-6 < x < 0$ *or* $0 < x \leq 5$

6. $y \leq 1$ *or* $3 \leq y < 4$

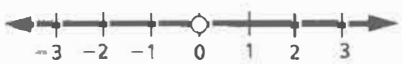
7.

8.



9.

10.



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2.4 Puzzle Time

Where Do Young Tigers Swim?

Write the letter of each answer in the box containing the exercise number.

Solve the inequality.

1. $4x - 7 < 9$
2. $-11 > 10 - 7x$
3. $\frac{x}{6} + 5 > 8$
4. $-\frac{x}{2} + 12 \geq 14$
5. $6x - 23 > 25$
6. $6 - \frac{x}{5} \geq -2$
7. $3 \geq -3(x - 13)$
8. $16 - 4x > 9 - 5x$
9. $2x + 7 \leq 2x + 8$
10. $-6(x - 1) < -14(x - 5)$
11. $12x + 4x - 11 \geq 16x + 17$
12. $3(1 - x) + 10x \leq 9(x - 2) + 7$
13. The students in charge of the class booth at a carnival would like to earn \$3 for every item they sell. They spent \$55 for the materials to make the items. Solve the inequality $3x - 55 \geq 65$, which represents how many items they need to sell to make a profit of at least \$65.
14. A triangle has a base of 14 centimeters and a height of $(3x - 4)$ centimeters. The area of the triangle is greater than 56 centimeters. Solve the inequality $\frac{1}{2}(14)(3x - 4) > 56$ to find the possible values of x.

Answers

N. all real numbers

K. $x \geq 7$

P. $x < 8$

E. $x > 3$

O. $x < 4$

I. $x > 8$

O. $x \geq 40$

Y. $x \leq -4$

T. $x > 4$

L. $x > -7$

T. no solution

H. $x \geq 12$

I. $x \leq 40$

T. $x > 18$

5	9		3	7	2		12	6	14	11	4		10	1	13	8

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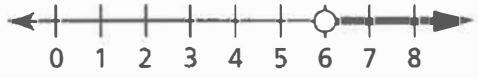
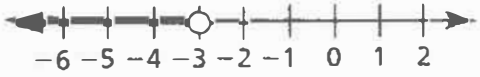
2.5 Start Thinking

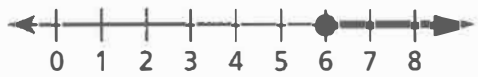
The local zoo waives its entry fee for children under age 3 and for senior citizens age 65 and older. Write two separate inequalities for this situation and graph them on the same number line. How could you describe the customers the zoo charges an entry fee for?

2.5 Warm Up

Write an inequality that is represented by the graph.

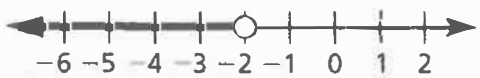
1. 

2. 

3. 

4.

5.

6. 

2.5 Cumulative Review Warm Up

Solve the equation. Check your solution.

1. $6 = \frac{z}{-5} + 4$

2. $\frac{h - 5}{6} = 1$

3. $9y - 2y = 42$

4. $15v - 9v - 15 = 81$

5. $4c + 9 - c = -15$

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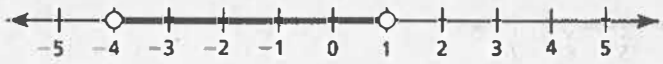
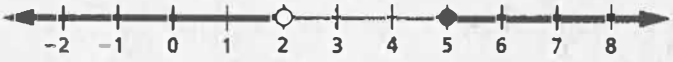
2.5 Practice A

In Exercises 1–3, write a compound inequality that is represented by the graph.

1. 

2.

3. 

In Exercises 4–6, write the sentence as an inequality. Graph the inequality.

4. A number t is less than 5 and greater than 3.

5. A number m is less than -3 or greater than or equal to 1.

6. A number s is at least -2 or less than -6.

7. You are purchasing a new refrigerator. To fit in the space, the width of the refrigerator cannot be more than 42 inches. To meet your storage requirements, the width of the refrigerator must be at least 36 inches. Write a compound inequality that represents this range.

In Exercises 8–13, solve the inequality. Graph the solution.

8. $3 < x + 4 \leq 10$

9. $15 > -5t \geq -10$

10. $-4 \geq 8 - 4q \geq -12$

11. $h + 7 < 5$ *or* $-9h < -45$

12. $-11 > m + 4$ *or* $2m \geq -16$

13. $3w + 2 < 5$ *or* $-w + 8 \leq 2$

14. A bike shop rents bikes with heights ranging from 18 inches to 26 inches. The shop says the height of the bike should be about 0.6 times a cyclist's leg length. Write and solve a compound inequality that represents the leg lengths of the cyclists the shop does *not* provide bikes for.

In Exercises 15–18, solve the inequality. Graph the solution, if possible.

15. $24 < -5t + 4 < 16$

16. $3p - 2 \geq 4$ *or* $7p > -28$

17. $-n + 5 \leq 9$ *and* $n + 3 > 8$

18. $a - 6 \leq 3$ *or* $3a + 2 > 8$

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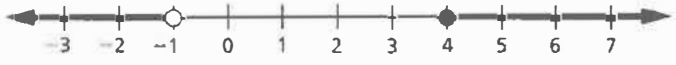
2.5 Practice B

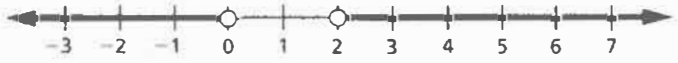
In Exercises 1–3, write a compound inequality that is represented by the graph.

1.

2.



3.



In Exercises 4 and 5, write the sentence as an inequality. Graph the inequality.

4. A number d is less than or equal to 2 and greater than or equal to -2.

5. A number m is no less than -1 or less than or equal to $-5\frac{1}{3}$.

In Exercises 6–11, solve the inequality. Graph the solution.

6. $-2 \geq 10 - 3g \geq -8$

7. $-4 < 2p + 8 < 18$

8. $-13 > q + 2$ *or* $5q \geq -15$

9. $15 < -v - 8$ *or* $3v + 4 \geq 10$

10. $-6 < \frac{1}{3}(6y + 12) < 14$

11. $42 < 6(3 - k)$ *or* $\frac{1}{2}(14k - 8) \geq 10$

12. A tuxedo rental shop rents tuxedos with sleeve lengths from 20 inches to 40 inches. The shop says the length of the sleeves should be about 1.2 times a person's arm length. Write and solve a compound inequality that represents the arm lengths of people the shop does *not* provide tuxedos for.

In Exercises 13–16, solve the inequality. Graph the solution, if possible.

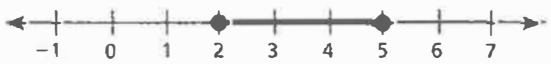
13. $8w - 5 > 12w + 3$ *or* $3 > -\frac{3}{4}w + 9$

14. $2t - 15 < 3t - 17$ *and* $t - 13 < -19$

15. $3d + 17 \leq 11$ *or* $-4d + 4 < -3d + 24$

16. $4x - 9 < 9x + 6 < 4x + 16$

17. Write a real-life story that can be modeled by the graph.



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2.5 Enrichment and Extension

Special Cases of Compound Inequalities

Example: Solve the compound inequality, graph the solution, and then state the solution in interval notation: $2x < x - 1$ *and* $10 \geq 2(x + 4)$.

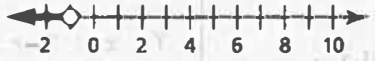
$2x < x - 1$ *and* $10 \geq 2(x - 4)$

$x < -1$ *and* $5 \geq x - 4$

$x < -1$ *and* $x \leq 9$

The graphs only overlap at $x < -1$.

So, the answer is only $x < -1$.



Interval Notation: $(-\infty, -1)$

Solve the compound inequality, graph the solution, and state the solution in interval notation, if possible.

1. $9x - 5 - 4x \geq 3x + 5$ *or* $2(3x + 1) \geq 5x$

2. $6x + 2 \leq 5x + 1$ *and* $8 \geq 4(x - 1)$

3. $5 \leq -2x + 3 < 1$

4. $2x + 5 > x + 9$ *or* $\frac{3x - 2}{4} \geq 4$

5. $5x + 3 < 4(x + 1)$ *or* $2x - 5 \geq 6x - 11 - 3x$

6. $\frac{7x - 5}{3} \geq 3$ *and* $3x + 1 \geq 4x - 1$

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2.6 Practice A

In Exercises 1–9, solve the inequality. Graph the solution, if possible.

1. $|x| < 4$
2. $|y| \geq 3.5$
3. $|k + 8| > 2$
4. $|y - 4| \leq 8$
5. $|3w - 8| \geq -2$
6. $|3c + 4| > 7$
7. $|6b + 4| < -8$
8. $|8 - 3r| < 5$
9. $|5y - 2| + 5 > 0$

10. The rules for a book report say that the report should have 300 words with an absolute deviation of at most 20 words. Write and solve an absolute value inequality that represents the acceptable number of words.

11. Describe and correct the error in solving the absolute value inequality.

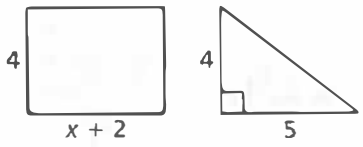
$|x + 2| < -3$

$x + 2 < -3$ or $x + 2 > 3$

$x < -5$ or $x > 1$

In Exercises 12–14, write the sentence as an absolute value inequality. Then solve the inequality.

12. A number is less than 4 units from 0.
13. A number is more than 11 units from 8.
14. Half a number is at least 2 units from 20.
15. A nail manufacturer throws out nails with lengths that are not within 0.05 inch of the mean length of the batch. The lengths (in inches) of the nails in a batch are 0.42, 0.53, 0.55, 0.48, and 0.51. Which nail(s) should be thrown out?
16. Write an absolute value inequality that represents the situation. Then solve the inequality. The difference between the areas of the figures is at most 6.



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2.6 Practice B

In Exercises 1–9, solve the inequality. Graph the solution, if possible.

1. $|2x - 9| < -8$
2. $|5q - 1| - 7 \geq 2$
3. $|y - 2| + 11 > 0$
4. $5|12 - r| > 15$
5. $-2|3d - 5| \leq 10$
6. $3|2a + 8| - 11 \leq -5$
7. $-2|1 - 3h| + 9 < -12$
8. $5|-p + 2| + 4 > 4$
9. $\frac{1}{3}|2x + 3| - 1 \leq 8$

10. The thermometer in a freezer is set at $-2°F$. This temperature varies by up to $3°F$ throughout the day. Write and solve an absolute value inequality that represents the range of temperatures (in degrees Fahrenheit) of the freezer throughout the day.

11. Describe and correct the error in solving the absolute value inequality.

$$\begin{aligned} |x - 5| + 2 &< 8 \\ -8 &< x - 5 + 2 < 8 \\ -5 &< x < 11 \end{aligned}$$

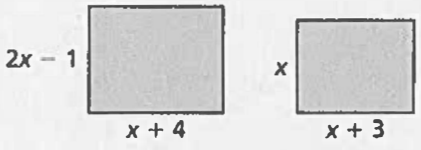
In Exercises 12–14, write the sentence as an absolute value inequality. Then solve the inequality.

12. A number is more than 12 units from 0.

13. One-third of a number is at least 5 units from 31.

14. Twice a number is no more than 7 units from 13.

15. Write an absolute value inequality that represents the situation. Then solve the inequality. The difference between the perimeters of the figures is not greater than 10.



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2.6 Enrichment and Extension

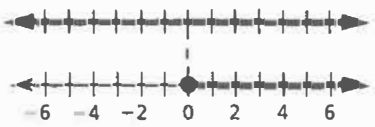
Critical Thinking: Absolute Value Inequalities

Example: Solve the absolute value inequality, graph the solution, and then state the solution in interval notation. Check your solution.

$x \leq x$ *and* $x \geq -x$

$0 \leq 0$ *and* $2x \geq 0$

$0 \leq 0$ *and* $x \geq 0$



The graphs only overlap at $x \geq 0$.

$0 \leq 0$ is a true statement and implies the answer of all real numbers.

So, the answer is $x \geq 0$.

Interval Notation: $[0, \infty)$

In Exercises 1–6, solve the absolute value inequality, graph the solution, and state the solution in interval notation, if possible.

1. $|x + 3| < x$
2. $|2x - 1| > 0$
3. $-2|x - 5| \geq 10$
4. $|3x + 2| \leq 0$
5. $|x| > x$
6. $|x| \geq x$

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2.6 Puzzle Time

What Do Electrons Wear On Their Feet?

Write the letter of each answer in the box containing the exercise number.

Solve the inequality.

1. $|x| < 8$
2. $|x| \geq \frac{11}{2}$
3. $|x + 7| > 3$
4. $|3x - 9| > 21$
5. $\left|x - \frac{3}{2}\right| \leq \frac{15}{2}$
6. $|6x - 12| < 42$
7. $|8x - 19| > 37$
8. $|2x - 5| + 11 \leq 24$
9. $6|3x - 10| \geq 48$
10. $4|2x + 6| - 14 \leq 10$
11. $9|-x + 5| + 16 \geq 16$
12. $\frac{3}{4}|8x + 16| - 3 \geq 15$
13. The players on a basketball team decided that they wanted to score 750 points by the end of the season. The coach promised pizzas if the team scored within 50 points of its goal. Solve the inequality $|x - 750| \leq 50$, which represents the total possible number of points the team could score to earn pizzas.
14. An engineer assigned to design a product wanted the length of the main part to be within 0.004 foot of 3 feet. Solve the inequality $|x - 3| \leq 0.004$, which represents the different lengths of the part that would be acceptable to the engineer.

Answers

A. $-6 \leq x \leq 9$

O. $x < -10$ or $x > -4$

K. $700 \leq x \leq 800$

H. $x < -\frac{9}{4}$ or $x > 7$

K. $-4 \leq x \leq 9$

O. $-8 < x < 8$

C. $-6 \leq x \leq 0$

S. $2.996 \leq x \leq 3.004$

S. $-5 < x < 9$

N. all real numbers

I. $x \leq -\frac{11}{2}$ or $x \geq \frac{11}{2}$

C. $x \leq -5$ or $x \geq 1$

T. $x \leq \frac{2}{3}$ or $x \geq 6$

S. $x < -4$ or $x > 10$

5	11	9	2		14	7	3	10	8		6	1	12	13	4
.				–											

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Chapter 2 Cumulative Review

In Exercises 1–4, add or subtract.

1. $5 - 8$ **2.** $-1 + (-17)$ **3.** $-5 - (-7)$ **4.** $20 + (-3)$

In Exercises 5–12, multiply or divide.

5. $-9(8)$ **6.** $-19 \bullet (-2)$ **7.** $8 \bullet (-1)$ **8.** $10(-2)$

9. $-42 \div 6$ **10.** $52 \div (-4)$ **11.** $-40 \div (-2)$ **12.** $14 \div (-7)$

In Exercises 13–15, solve the problem and specify the units of measure.

13. You shoveled your neighbor's driveway in 3 hours and were paid \$21. What was your hourly wage?

14. How many packs of gum can you buy with \$4.76 if one pack costs \$1.19?

15. Your fish tank is 2 feet wide, 2 feet deep, and 5 feet long. The tank is filling at a rate of 3 cubic feet per hour. After how many hours will it be 75% full?

In Exercises 16–19, solve the equation, justify each step, and check your answer.

16. $x + 2 = 9$ **17.** $7b = 49$ **18.** $x + (-10) = 51$ **19.** $\frac{y}{13} = 5$

In Exercises 20–22, solve the equation. Check your solution.

20. $\frac{2}{11} + y = \frac{8}{11}$ **21.** $-5\pi + a = 7\pi$ **22.** $w \div (-4) = -0.9$

In Exercises 23 and 24, write and solve an equation to answer the question.

23. You and your friend chip in to buy a new gaming computer, which costs \$1024. How much do each of you pay for the new gaming computer?

24. It cost \$510 to get your car fixed. If it was \$375 for parts, how much did the mechanic charge for the work to fix your car?

In Exercises 25–30, solve the equation. Check your solution.

25. $5x - 10 = -10$ **26.** $36 = 12u - 3u$ **27.** $11 = 1 - w$

28. $8 = \frac{c}{7} + 4$ **29.** $17x - 3 - 5x = 45$ **30.** $\frac{z + 5}{2} = 3$

31. Write and solve an equation to answer the question. It cost \$1031 for a camping trip. It cost \$231 to park for the trip and \$200 a day for the camping site. How many days was the camping trip?

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Chapter 2 Cumulative Review (continued)

In Exercises 32–40, solve the equation. Check your solution.

32. $27 - 5x = 4x$

33. $-8w + 17 = 2w - 3$

34. $9h - 6 = 2h + 36$

35. $5(x + 4) = 2(16 + 2x)$

36. $3k - 11 - 7k = 9k + 3 + k$

37. $-35 = -5(2r - 3)$

38. $-7(-x + 3) = -6(5 - x)$

39. $-2(5x - 10) = 5(3 - 2x) - x$

40. $\frac{4}{5}(10y - 10) = \frac{2}{7}(7y + 14)$

41. A protein bar has 33% of the protein you need daily. You must get the remaining 12 grams of protein from other sources. Approximately how many grams of protein do you need daily? Round your answer to the nearest tenth of a gram.

42. Two different golf country clubs have the following membership fees and monthly costs. Ludwig's Fast 18 charges a \$100 membership fee and then \$30 a month. Ocean Shore Country Club charges a \$160 membership fee and then \$10 a month. Find the number of months you must be a member to have the same cost for each club.

In Exercises 43–45, solve the equation. Determine whether the equation has *one solution, no solution,* or *infinitely many solutions.*

43. $y + 3 - 12 = y - 9$

44. $24v - 22 = -4(1 - 6v)$

45. $4(6x + 1) = 3(4x + 3) + 43$

In Exercises 46–49, simplify the expression.

46. $|-0.4 \cdot 7|$

47. $-|14|$

48. $|12| - |-12|$

49. $\left|-\frac{24}{-2}\right|$

In Exercises 50–56, solve the equation. Graph the solution(s), if possible.

50. $|x + 7| = 2$

51. $|d| = -2$

52. $|-3r| = 12$

53. $\left|\frac{y}{5}\right| = 10$

54. $-4|7x - 5| = 8$

55. $|2n - 10| - 6 = -4$

56. $-6|6 - 3n| = -36$

57. A regulation professional basketball is to be inflated to 8 pounds per square inch with a margin of error of 0.2 pound per square inch. Write and solve an equation to find the minimum and the maximum air pressure to which the basketball can be inflated.

In Exercises 58–60, solve the literal equation for *y*.

58. $y - 3x = 9$

59. $3x + y = 7$

60. $32x - 8y = 64$

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Chapter 2 Cumulative Review (continued)

In Exercises 61–64, write the sentence as an inequality.

61. A number n is less than 4.

62. A number y minus 8 is greater than or equal to 10.

63. The number 21 is at least a number t times 3.

64. Two-thirds of a number b is no more than 12.

In Exercises 65–68, tell whether the value is a solution of the inequality.

65. $x - 5 > 10; x = 2$

66. $\frac{2}{3}y - 12 \leq 24; y = 48$

67. $30 - 6w < -3(5 + 7w); w = -4$

68. $2(4z + 6) \geq -8z + 12; z = -1$

69. You and your friend are fishing when your friend catches a 15-inch largemouth bass. You tell your friend that last week you caught one at least twice as big.

a. Write an inequality that represents the possible lengths of the fish you caught.

b. Is 29 inches a solution of the inequality? Explain.

In Exercises 70–75, solve the inequality. Graph the solution.

70. $4 + y \geq 24$

71. $c + 2 \leq 9$

72. $-5h + 6h \geq 8 - 1$

73. $b + 4 - 8 \geq 9$

74. $28 - (-t) > -40 + 18$

75. $20 - 3z + 4z < 9 - 20$

In Exercises 76 and 77, write the sentence as an inequality. Then solve the inequality.

76. A number plus 12 is no more than 8.

77. The difference of 20 and a number is at least 15.

78. A lift gate on the back of a semi-truck trailer can lift at most 2000 pounds. You are loading a pallet that weighs 1835 pounds plus yourself. Write an inequality that represents the possible weights and solve the inequality.

In Exercises 79–84, solve the inequality. Graph the solution.

79. $9w \leq 27$

80. $-40 \geq 8y$

81. $\frac{1}{5}a > 7$

82. $\frac{3}{-4}g < 18$

83. $-7 > -\frac{1}{11}d$

84. $\frac{w}{-4} \leq 12$

85. You have \$900 to spend on a new deck. Write and solve an inequality that represents the cost per square foot that you can pay for the new deck if you want to build a deck that is 10 feet long and 15 feet wide.

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Chapter 2

Cumulative Review (continued)

In Exercises 86–88, solve the inequality. Graph the solution.

86. $3u - 7 \leq 14$ **87.** $-11 \geq 13 - 6n$ **88.** $7 + \frac{p}{3} < 2$

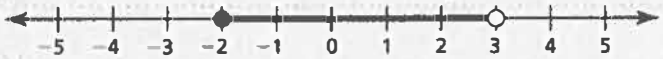
In Exercises 89–91, solve the inequality.

89. $7w + 1 < w - 5$ **90.** $3(g - 5) > 3g$ **91.** $2(h - 2) \leq -2(1 - h)$

92. You are saving \$12 per week to purchase a new kayak. Prices start at \$300 and go up. Your parents give you \$144 to help you purchase your kayak. Write and solve an inequality to find the number of weeks you need to save to purchase the kayak.

In Exercises 93 and 94, write a compound inequality that is represented by the graph.

93.



94.

In Exercises 95 and 96, write the sentence as an inequality. Graph the inequality.

95. A number h is greater than 3 and less than 8.

96. A number m is more than 4 or less than or equal to −3.

In Exercises 97–101, solve the inequality. Graph the solution.

97. $-1 < 9 + n < 17$ **98.** $-50 < 7k + 6 < -8$ **99.** $g + 5 \geq 12$ *or* $\frac{g}{9} < 0$

100. $8t + 8 \geq -64$ *and* $-7 - 8t \geq -79$ **101.** $2x < 10$ *or* $\frac{x}{2} \geq 3$

In Exercises 102–107, solve the inequality. Graph the solution, if possible.

102. $|y| < 4$ **103.** $|h - 7| \geq 5$ **104.** $|4x - 12| > -7$

105. $|2x - 8| < -10$ **106.** $|4w - 7| + 8 \geq 17$ **107.** $|10 + 4x| < 14$

108. The ideal diameter of a piston for a car is 88 millimeters, and the actual diameter can vary from the ideal diameter by at most 0.007 millimeter. Write and solve an absolute value inequality that represents the actual diameter.

109. In a poll of 100 people, you have an approval rating as class president of 78% with a 3% margin of error. Write and solve an absolute value inequality that represents your approval rating.

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